A compilation of

Scientific Information on

Nabugabo Ramsar Site, Uganda

Proceedings of the Scientific Conference held at Nabugabo in January, 2001

Edited by:

Busulwa H., P. G. Mafabi and L. M. Ndawula

2005

THE VALUE OF NABUGABO LAKES IN THE CONSERVATION OF *OREOCHROMIS ESCULENTUS*

Nagayi- Kalule J. F[1] and R. Ogutu-Ohwayo[1].
[1]Fisheries Resources Research Institute P. O. Box 343 Jinja, Uganda.

Abstract

The wide-spread impact of exotic fishes especially *Oreochromis niloticus* and *Lates niloticus* together with over fishing in the Victoria and Kyoga lake basins during the 1950s and 1960s, caused endemic species such as the previously most important *Oreochromis esculentus* to become virtually extinct in the two lakes by the 1970s. Based on reports of presence of this native species in some satellite lakes within the two lake basins, a set of satellite lakes in the Victoria basin (Nabugabo lakes: Kayanja and Kayugi), were sampled between 1997–2002 with an objective of assessing their value as conservation sites for *O. esculentus*. Other satellite lakes (Mburo and Kachera) also in the Victoria basin, and Lemwa, Kawi and Nabisojjo, in the Kyoga basin, were sampled for comparison.

Among the Nabugabo lakes, *O. esculentus* was more abundant in Lake Kayanja (20.1 %) of the total fish catch by weight compared to Lake Kayugi (1.4 %). The largest fish examined (38.7 cm TL) was caught in Lake Kayugi, (also the largest in all satellite lakes sampled), while the smallest (6.6 cm TL) was from Lake Kayanja. Fish from Lake Kayugi had a higher condition factor K (1.89± 0.02) than that from Lake Kayanja (1.53±0.01), which was the second highest (compared with other satellite lakes) to Lake Kawi (1.92±0.2).

Diatoms, especially *Aulacoseira*, which were previously known to be the best food for *O. esculentus* in Lake Victoria were mostly encountered (93.2 %) in fish stomachs from Lake Kayugi. In Lake Kayanja the dominant food item was the blue green algae (*Planktolyngbya*) while *Microcystis* was the most abundant diet item in fish from other satellite lakes. There were more male than female fish (ratio 1:0.91 and 1: 0.79 in lakes Kayugi and Kayanja respectively). This is comparable to the situation in Lake Victoria before the species got depleted. The highest mean fecundity was (771±218 eggs) recorded in Lake Kayugi compared to Lake Kayanja (399±143). Based on the results from Lake Kayugi, where diatoms dominated the diet of *O. esculentus* and where the largest, most fecund and healthy fish were found, this lake would be a most valuable site for the conservation of *O. esculentus* and the best source of fish, for restocking and for captive propagation. This lake is therefore recommended for protection from over exploitation and misuse.

Key words: Condition factor, Fecundity, Satellite lakes

Introduction

Fish introductions in the lakes Victoria and Kyoga Africa have resulted into the disappearance of endemic species (Fryer, 1961; Welcomme, 1968; Lowe Mc Connell, 1987 and Ogutu-Ohwayo, 1990) especially *Oreochromis esculentus*. Up to the 1900s *O. esculentus* together with *O. variabilis* were the most important commercial fish species and Lake Victoria then contained large stocks of *O. esculentus* (Graham, 1929). About the period 1905 to 1916, when gill nets were introduced into different parts of Lake Victoria, coupled with the growth of urban centers and communication routes around the lake, the fishing industry assumed a commercial status with *O. esculentus* as one of the main target species (Mann, 1969; Miles & Keenleyside, 1991; Balirwa, 1992). From the 1930s to the 1950s fish catches dropped and fish size declined due to increased fishing pressure (Fryer & Iles, 1972; Fryer, 1973) and increasing use of small mesh sized gill nets (Witte & van Densen, 1995). This made *O. esculentus* one of the most endangered and threatened fish species and deprived the people who depended on it for food and employment. A survey carried out in the satellite lakes showed that the species still existed in some satellite lakes including the Nabugabo lakes. The study of the satellite lakes (Nagayi *et al.* unpublished report), showed that the catches mostly comprised haplochromines (59.9 %), followed by *O. esculentus* (26.3 %). The rest of the species contributed less than 5 % each.

Graham (1929), recorded *O. esculentus* of 30 cm TL in Kavirondo Gulf and 31 cm TL in the open lake. And according to Greenwood (1966), the modal adult size was 30-32 cm TL in Lake Victoria. However, recent studies on some satellite lakes (Mburo and Kachera in the Victoria basin; Lemwa, Kawi and Nabisojjo in Kyoga basin), recorded fish of 7-29.8 cm TL with a modal size of 16.0-20.9 cm TL. The largest (29.8 cm) was caught in Lake Mburo (Nagayi *et al.* unpublished report). In addition, fish from the sampled satellite lakes had an overall mean value of the condition factor K of 1.78±0.01. Lake Kawi recorded the highest (1.92±0.01), followed by Lake Kachera (1.87±0.02) and the lowest in Lake Nabisojjo (1.65±0.02) (Nagayi *et al.* unpublished report), compared to a historical value of 2 in Lake Victoria (Graham, 1929).

Studies in the satellite lakes showed the species to be a phytoplankton feeder with the blue green algae, especially *Microcystis* as the most abundant (26.2 %), food item in fish from lakes Kachera, Mburo and Lemwa. *Aulacoseira*, which was known to be the best food of the species in Lake Victoria (Graham, 1929; Fish, 1951, 1955; Lowe-McConnell, 1956; Welcomme, 1966; Payne,

1971; Bailey *et al.*, 1978), was mostly found in Lake Kawi (46.8 %). In Lake Victoria, *Aulacoseira* would form 48.75 % of the total algal cells present in all fish stomachs (Payne, 1971). Schools of *O. esculentus* were reported to follow concentrations of diatoms in suspension (Gee & Gilbert, 1967; Fryer & Iles, 1972), suggesting that, diatoms were its most preferred food item.

The satellite lakes study showed that there were generally more males than females (Nagayi *et al.* unpublished report). The data gathered showed a ratio of 1:0.93 in Lake Kachera, 1:0.52 in Lake Kawi, 1:0.74 in Lake Lemwa and 1:0.69 in Lake Nabisojjo. In Lake Mburo however, there were more females than males (1:1.03). Likewise, Lowe-McConnell (1956), had reported a male to female sex ratio of 1:1 in Lake Victoria, even though in most areas males were more than females. For example, there were, 1:0.72 in Pilkington Bay, 1:0.64 in Hannington Bay and 1:1.01 Ekunu Bay.

Fecundity was proportional to the size of the fish with an overall mean fecundity of 457±14 eggs in the satellite lakes. The highest fecundity (507±32 eggs) was recorded in Lake Kawi while the lowest (351±19) was from Lake Mburo (Nagayi *et al. unpublished*). In Lake Victoria, fecundity ranged from 324 eggs in a fish of 17 cm TL to 1672 eggs in fish of 36 cm TL (Graham, 1929) indicating a reduction in the species reproductive potential in the satellite lakes.

Nabugabo area has been selected as one of the RAMSAR Sites in Uganda. Some lakes in this area (for example lakes Kayanja and Kayugi) contain *O. esculentus*, which used to support a commercial fishery in Lakes Victoria and Kyoga before the species disappeared from these two main lakes. This study therefore, is aimed at evaluating the importance of these lakes in the conservation of *O. esculentus* compared with other lakes where the species exists. The evaluation is aimed at reaching a decision on how best to conserve the surviving populations, to improve their stocks and whether the Nabugabo lakes should be given priority in conservation efforts.

Materials and methods

Study area

There are four water bodies close to each other and collectively referred to as the Nabugabo lakes. These comprise the main Lake Nabugabo, and three other smaller lakes: Kayanja, Kayugi and Manywa (Fig.1). Apart from Lake Manywa, which had no accessible route to it, the other three lakes were sampled.

Lake Kayanja has a surface area of about 1.2 km^2 with a maximum depth of about 3.0m. Apart from the eastern shoreline, Lake Kayanja is surrounded by an extensive swamp, which is dominated by *Loudentia phragmitoides*. Nzonsemu and Kikoma streams drain into the swamp around this lake from the North-west and drains eastwards through Kanwa stream, into Nakiga Bay of Lake Victoria. Lakes Kayugi and Manywa are about 0.5 km apart with a total combined area of about 0.2 km^2. These two lakes are separated by a thick papyrus swamp, which is connected to Lake Nabugabo via River Juma. Lake Kayugi has a maximum depth of about 3.0m. The swamp around these two lakes (Kayugi and Manywa) is served by River Kagona from the Northwest as shown in Figure 1 in the introduction chapter (Pg. 5).

Sampling of *O. esculentus* in the Nabugabo satellite lakes was done using three fleets of identical multifilament nylon gill-nets. Fish were measured (total and standard lengths) in centimetres and weighed in grams. The specimens were then dissected and, the stomach fullness and the sex of the fish determined. Female gonads at maturity stage V and VI and stomachs, which contained food, were removed and preserved in 50 % Ethanol and 5 % Formalin solution respectively, in separate numbered bottles. In the laboratory, the stomach contents were allotted points according to the scheme modified from Hynes (1950) and the food categories were rated in proportion to their relative percentage volumes. The importance of each food item was obtained from the points allotted by calculating the percentage relative importance of the food in the stomachs. Eggs in the gonads of an individual fish were counted to generate data of 'absolute fecundity'.

Results

Relative abundance

Out of all the fish caught, *O. esculentus* was relatively more abundant in Lake Kayanja (20.1 %) while it was very scarce in Lake Kayugi (1.4 %). However, when all other lakes are compared the species was most abundant in Lake Nabisojjo (58.1 %), in the Kyoga basin where the species was successfully stocked.

Length frequency distribution of Oreochromis esculentus

The largest fish in Lake Kayugi was 38.7 cm TL and the fish in this lake had a modal size of 16-21cm TL, while in Lake Kayanja the largest fish was 28cm

TL with a modal size of 14-18 cm TL. The largest fish in Lake Kayugi (38.7 cm TL) was also the biggest specimen compared to all the sampled satellite lakes. The fish in Lake Kayugi were generally much bigger than the rest put together.

Condition factor K

The condition factor of the species in lakes Kayanja and Kayugi generally increased with size of fish (Figure 2). The fish from Lake Kayugi had a higher condition factor K (1.89 ± 0.02) than those from Lake Kayanja (1.53 ± 0.01). However, the K value of the fish in Lake Kayugi was the second highest to that of Lake Kawi (1.92 ± 0.01), in the Kyoga basin area.

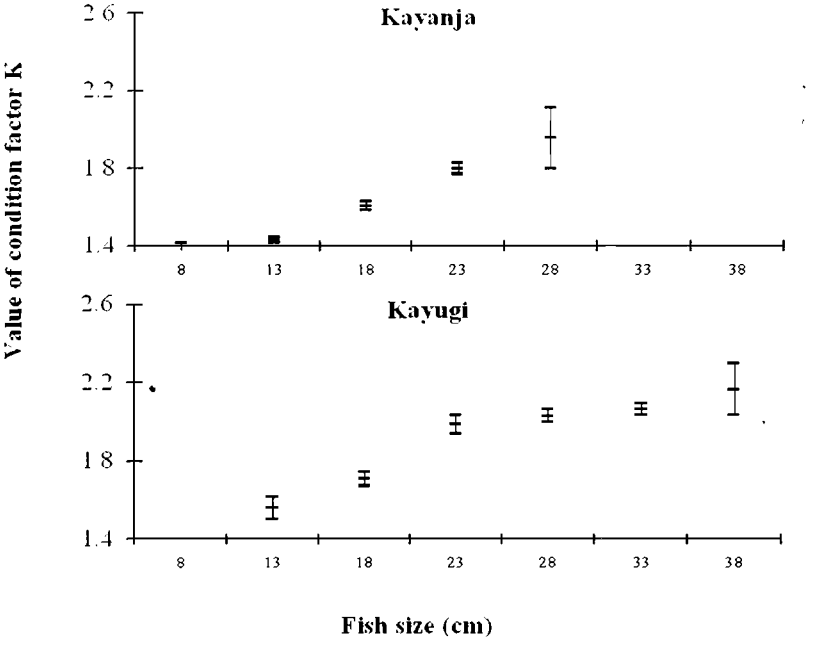

Fig 2: Variation in the value of the condition factor with size of *O. esculentus* in the Nabugabo lakes

The food of *Oreochromis esculentus*

The stomach contents of *O. esculentus* from Lake Kayugi were dominated by the diatom *Aulacoseira* (93.1 %), and compared with other satellite lakes, the recorded value in Lake Kayugi was the highest, followed by Lake Kawi (46.8 %). In the available historical data, this diatom was regarded as the most important food of *O. esculentus* in Lake Victoria (Fish, 1951, 1955; Lowe-McConnell, 1956; Welcomme, 1966; Bailey *et al.*, 1978). In Lake Kayanja,

the diet was dominated by blue-green algae especially *Planktolyngbya* (33.5 %). The study carried out in other satellite lakes revealed, blue-green algae especially *Microcystis* as the most abundant food item in fish stomachs (Appendix IV). Blue green algae are, however, considered to be a poor food quality and therefore, Lake Kayugi would provide the best source for *O. esculentus* seed because it contains the diatoms, considered to be the best food resource for the species.

Sex ratio and fecundity

The Nabugabo lakes had more males than females (M:F is 1:0.91 in Lake Kayugi and M:F is 1: 0.79 in Lake Kayanja) as observed in other satellite lakes. Available historical data on Lake Victoria also showed that there were more males than females. Fecundity in this regard i.e. the total egg count per fish (absolute fecundity) indicates the reproductive potential of the fish. Lake Kayugi had a higher mean value of fecundity (772 ± 218) than Lake Kayanja (399 ± 143). The study of the satellite lakes examined gonads of fish ranging between, 14.6 and 30.2 cm TL. The mean fecundity in Lake Kayugi was the highest compared to all other satellite lakes while that of Lake Kayanja was the second lowest overall (Table 1.)

Table 1. Comparing the variations in mean fecundity, size, and fecundity per size (length or weight) of *O. esculentus* between Nabugabo lakes and others.

Means	Kayanja	Kayugi	Kachera	Kawi	Lemwa	Mburo	Nabisojjo
Length (cm TL)	17.9±1.5	24.4±3.2	21±0.3	20±0.7	21±0.66	20±0.39	22.9±0.2
Wt (gm)	125±50.1	358±124	178±9.4	159±13.5	190±16.6	137±9.43	206±5
Fecundity	399±143	772±218	502±19.5	507±32.4	532±28	351±19	430±10.8
Fecundity/ Length	20±4.6	33±9	24±0.73	26±1.19	25±1	17.7±0.7	18.8±0.4
Fecundity/ Weight	3.8±0.64	4.3±2.85	3±0.1	3.5±0.37	2.9±0.19	2.75±0.1	2.1±0.1
No. of Fish specimens	8	4	56	13	9	36	29

Discussion and Conclusion

The Nabugabo lakes i.e. Kayanja and Kayugi are some of the few satellite lakes where *O. esculentus* survives today. Research in the satellite lakes showed that the population characteristics varied between these lakes when the various

aspects (relative abundance, population structure, condition factor, food, sex ratio, and fecundity) were investigated and compared. *O. esculentus*, which used to be the most abundant and important commercial fish species in Lake Victoria and Kyoga, is now apparently extinct in these main lakes. However, remnants of the species are not abundant where they occur. This indicates that, the species is in danger of becoming extinct and, therefore the remnant populations need to be protected. In Lake Victoria the historical *O. esculentus* used to feed on planktonic material with a strong preference to diatoms especially *Aulacoseira* (Fryer & Iles, 1972; Fish, 1951, 1955; Lowe-McConnell, 1956; Welcomme, 1966; Bailey *et al.*, 1978). However, data from the satellite lakes has shown a shift in the diet, from the dominance of diatoms to blue green algae especially *Microcystis* and this shift may suggest a superabundance of this species in the algal communities. Such a shift in phytoplankton species composition might result in a lower efficiency of energy transfer to higher trophic levels, since blue green algae are considered to be of poor food quality (Lampert 1981; Heerkloss *et al.* 1984; Harney 1987). In addition, some of the blue green algae are known to be toxic to the fish and other biota. In Lake Kayugi, where the diatom *Aulacoseira* was the most abundant food item in fish stomachs, the fish in this lake attained the largest size, were most fecund and had the second highest condition factor K. These attributes rate Lake Kayugi as the best source of *O. esculentus* for future restocking programs and indicates the value of the Nabugabo lakes in conservation of the species. *O. esculentus* needs to be protected first by gazzeting selected lakes including Lake Kayugi followed by systematic regulation of exploitation of the fisheries resources. Currently, Lake Kayugi is being protected by traditional myths (for example, boats/canoes are prohibited to operate on the lake and the few fishers use rafts, all intending fishers must seek permission from the lake's caretaker, and no drawing water from the lake using sooty saucepans). These myths have to a great extent controlled the level of fishing effort on the lake. Such traditions need to be further sustained and supported as one approach to protect the fishery and preserve the cherished *O. esculentus* species.

Recommendations

O. esculentus is considered an endangered fish species and should be protected wherever it occurs especially in Lake Kayugi, where fish with the best population characteristics are found. Protection should initially be through gazzeting of the lake followed by controlling access to the lake. Efforts should also be made to culture the fish and stock it in selected small water bodies especially dams to contribute to conservation and improvement of the stocks.

Acknowledgement

This study was funded by the GEF/World Bank through Lake Victoria Environmental Management Project (LVEMP) and the Fish Biology and Biodiversity Conservation Sub-Component, to whom we are very grateful. Sincere thanks go to Dr. J. S. Balirwa and Dr. Lucas Ndawula who read through several drafts of the document and gave valuable comments and criticisms.

References

Balirwa, J. S., (1992) The evolution of the fishery of *Oreochromis niloticus* (Pisces: Cichlidae) in Lake Victoria. *Hydrobiologia* 232: 85-89.

Bailey, R. G., C. S. Petr, T. S. Pimm, (1978) The ecology of the fishes in Nyumba ya Mungu reservoir, Tanzania. *Biol J. Linn. Soc.* Lond 10.

Fish, G. R., (1951). Digestion in *Tilapia esculentus*. Nature Lond. 167:900-901.

Fish, G. R., (1955). The food of Tilapia in East Africa. *Uganda J.* 19(1) 85-89.

Fryer, G., (1961) Observations of the biology of the cichlid fish *Tilapia variabilis* in the northern waters of Lake Victoria (East Africa). *Revue Zool. Bot. Afr.* 64: 1-33.

Fryer, G., (1973). The Lake Victoria Fisheries: Some facts and fallacies. *Biol. Conserv.* 5(4). 304-308.

Fryer, G. and **T. D. Iles**, (1972). The cichlid fishes of the Great Lakes of Africa Oliver & Boyd. Edinburgh. 641 pp.

Gee, J. M. and **Gilbert, M. P.**, (1967). The establishment of a commercial fishery for *Haplochromis* in the Uganda waters of Lake Victoria. *Occ. Pap. No. 5 E. Afr. Fresh- wat. Fish. Res. Org.* 36 pp.

Graham, M., (1929). The Victoria Nyanza, and its fisheries. A report on the fishing survey of Lake Victoria 1927-1928, and appendices. Crown Agents for colonies, London. 255 pp.

Greenwood, P. H., (1966). The fishes of Uganda. The Uganda Society, Kampala. (2nd edition). 131 pp.

Hynes, H. B. N., (1950.) The food of fresh water sticklebacks (*Gasterosteus aculecutus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. Department of Zoology, University of Liverpool 22 pp.

Keenleyside H. M. Miles, (1991). Behavior, ecology and evolution. Chapman & Hall Fish & Fisheries series 2.

Lowe-McConnell, R. H., (1956). Observations on the biology of Tilapia (Pisces : Cichlidae) in L. Victoria, E. Africa. *E. Afr. Fish. Res. Org. Suppl. Pub.* No. 1:72.

Lowe-McConnell, R. H., (1987). Ecological studies in tropical fish communities. University Press, Cambridge. 382 pp.

Mann, J. M. (1969). A resume of the revolution of the tilapia fisheries of Lake Victoria up to the year 1960. *East African Fresh water Fisheries Research Organis. Ann. Rep.* 1969.

Nagayi, Kalule J. F., R. Ogutu- Ohwayo and **S. J. Balirwa**, (*Un published*). Current distribution of the endangered native tilapiine (*O. esculentus*), and the need for its conservation. IDRC technical report.

Ogutu-Ohwayo, R., (1990). The decline in the native fishes of lakes Victoria and Kyoga (East Africa) and the impact of the introduced species, especially the Nile perch, *Lates niloticus* and Nile tilapia, *Oreochromis niloticus. Environmental biology of fishes*. 277: 81-96.

Payne, A. I., (1971). An experiment on the culture of *Tilapia esculenta* Graham and *Tilapia zillii* (Gervais) in fish ponds. *J. Fish Biol.* Vol. 3 no. 3 325-340.

Welcomme, R. L., (1966). Preliminary studies on the food of *Tilapia esculenta* Graham. EAFFRO. Annual report. 7pp.

Welcomme, R. L., (1968). Observations on the biology of the introduced species of Tilapia in L. Victoria. *Rev. Zool. Bot. Afr.* 76: 249-279.

Welcomme, R. L., (1988). International introductions of inland aquatic species. *FAO Fish. Tech. Pap.* 249-318.

Witte Frans & Wim L. T. van Densen, (1995). Fish stocks and Fisheries of Lake Victoria (A hand book for field observations) Samara Publishing Ltd. 404 pp.